



Cryogenic Testing of the Thermal Vacuum Chamber and Ground Support Equipment for the James Webb Space Telescope in Chamber A at Johnson Space Center

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Introduction



- This will be a top level summary of a large number of tests performed to get ready to test the cryogenic portion of JWST as a unit
- Schematically this is similar to taking the title of the talk and making it:
 - Cryo Testing the T/V Chamber and GSE for JWST
 - » Lots of shorthand and acronyms!
- Cold telescope and Instruments in the same chamber with room temperature ground support equipment (GSE) makes the cryogenic testing of JWST very challenging



Testing the James Webb Space Telescope (JWST)



- The Science Instrument Package – Integrated Science Instrument Module (ISIM) and pieces of the Optical Telescope Element (OTE) have been cryogenically tested separately at GSFC and MSFC respectively
- Now they come together to be tested as a unit, OTIS = ISIM + OTE, at Johnson Space Center (JSC)
- Because this test is very complex, a number of preliminary tests were performed on the GSE
- Due to the size of the sunshield and the phasing of the spacecraft and telescope, “test-as-you-fly” was not possible
 - JWST verification pioneers the new verification paradigm, stitching together tests with validated models



OTIS Cryo Test



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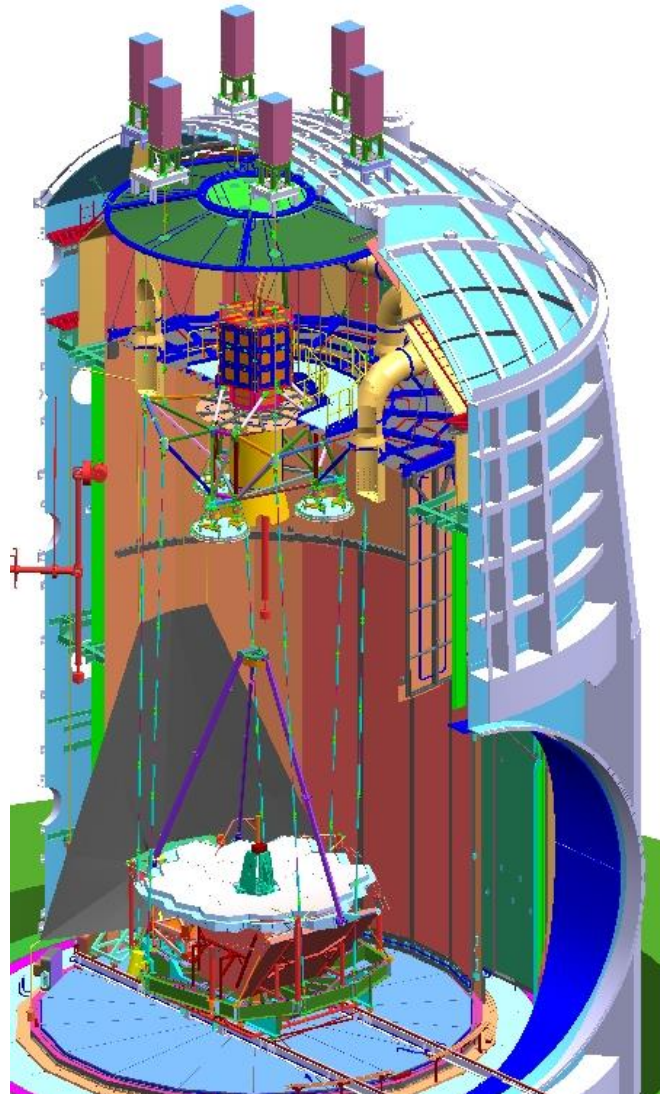


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OTIS cryo test is scheduled for 92 days, beginning mid-July 2017

Test is on the JWST Observatory critical schedule path

Pathfinder developed as a schedule risk reduction



Chamber A:
height 36m,
diameter 20m

20K helium shroud:
height 20m,
diameter 14m.

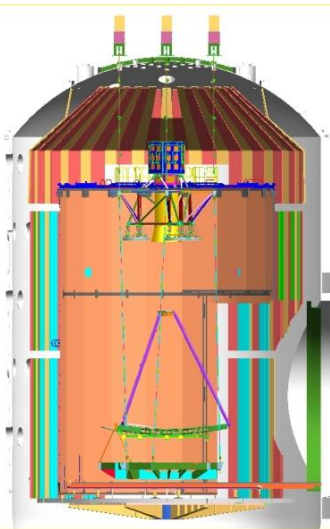
Door diameter 12m



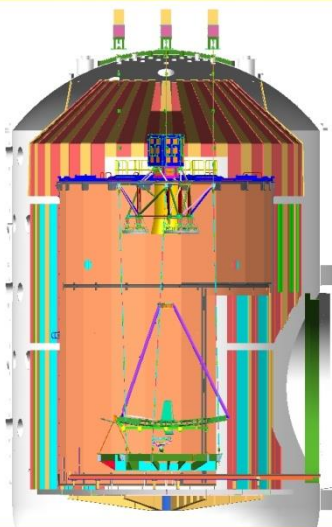
Preliminary Tests - Pathfinder



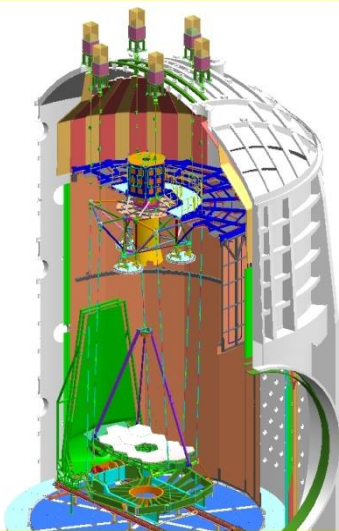
OGSE-1



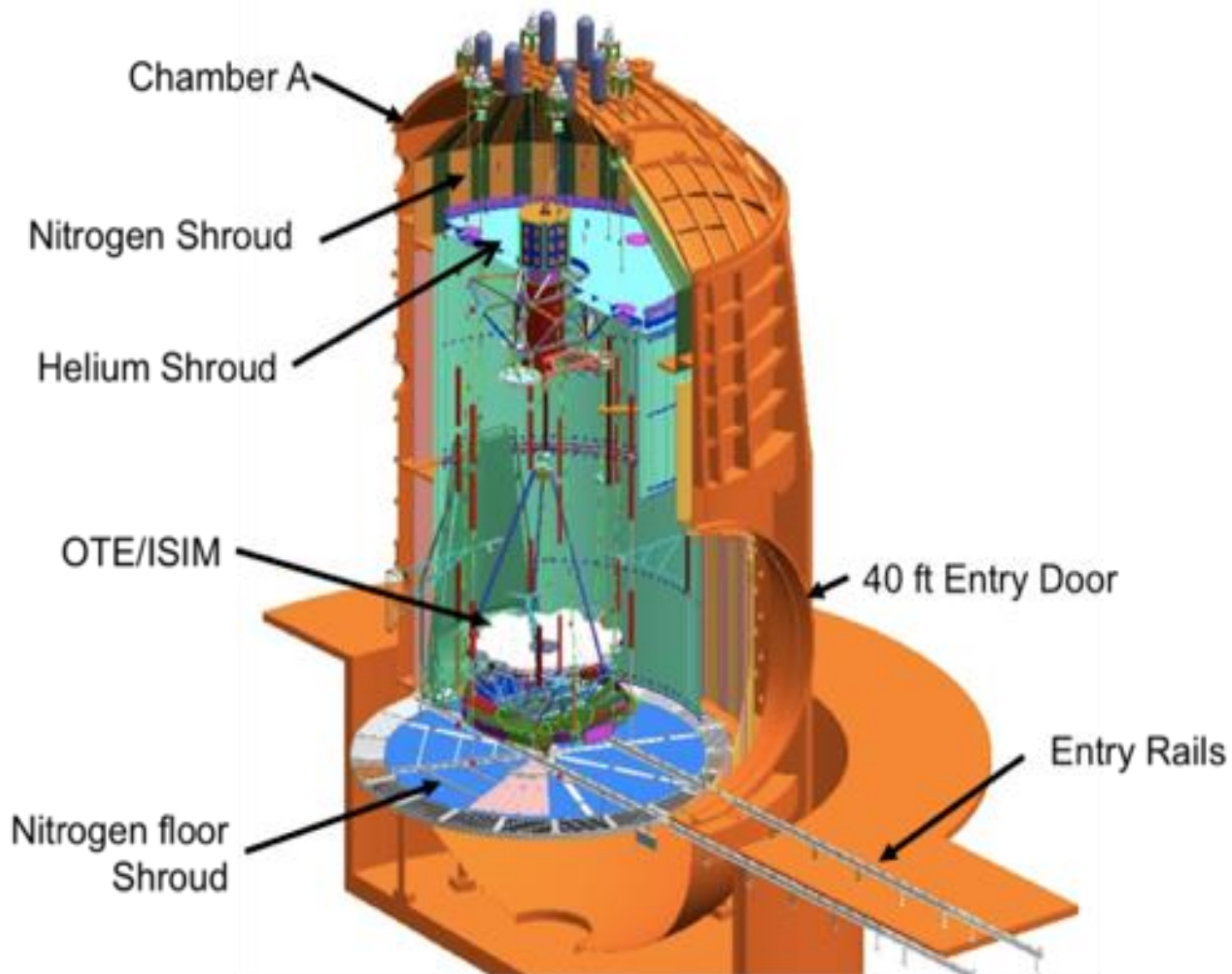
OGSE-2



Thermal Pathfinder (TPF)



Chamber A





Chamber A and Ground Support Equipment (GSE)

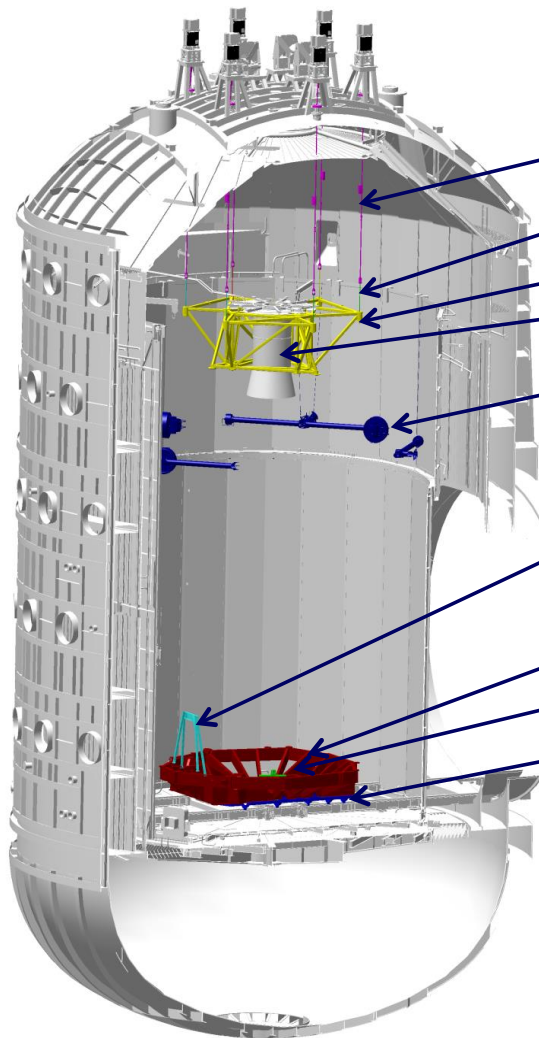


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Down Rods

Down Rod Studs

USF

CoCOA Plug

4x PG Booms and Canisters (not shown)

» With PG Boom GHe Shroud Closeouts

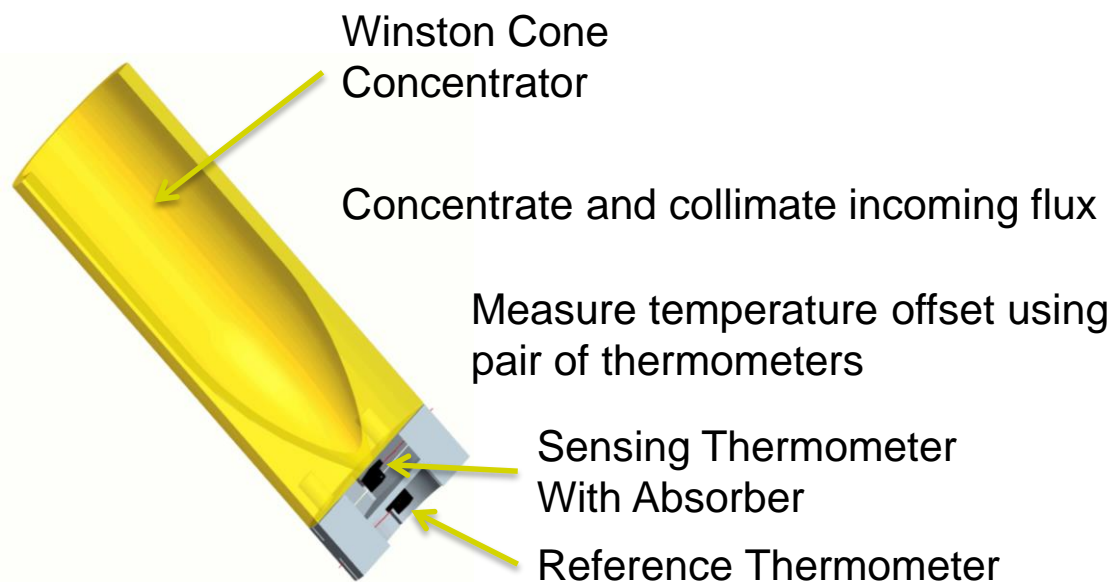
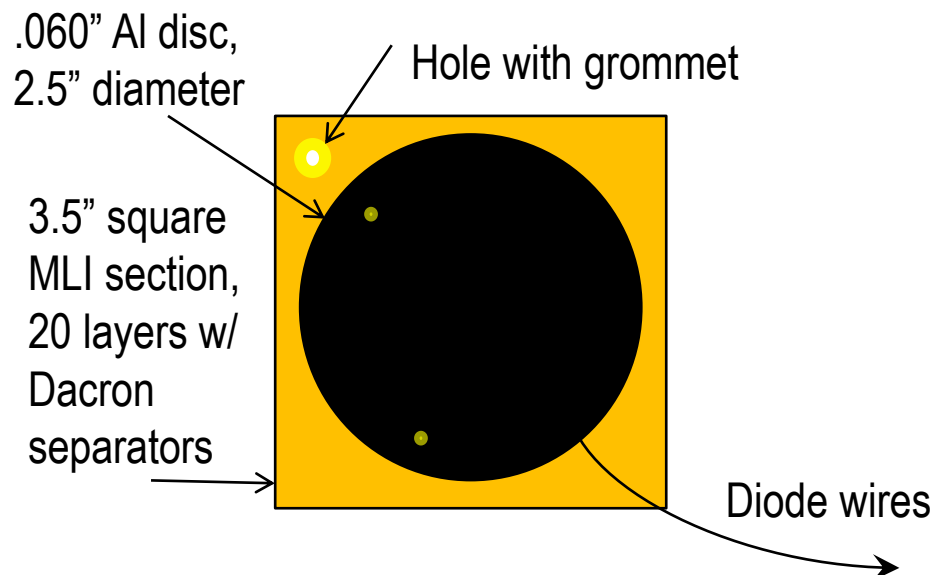
DTA Offloader Frame

HOSS

ADM Bracket

DSERS Frame

- Pressure Transducers
- Residual Gas Analyzers (RGAs)
- Thermometry
- Calorimeters [see right]
 - Non-directional
- Radiometers [see below]
 - 11° acceptance (half angle)

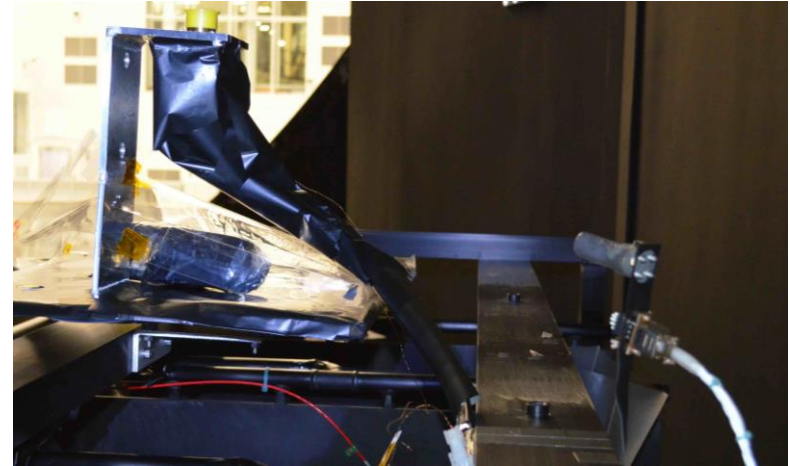




Troublesome Instrumentation



- **Cryogenic Quartz Crystal Microbalances (CQCMs)**
 - While the depositing surface remains cold the electronics dissipate many mW and sometimes have difficulties below 25 K
 - MLI with black outer layer is effective at radiation suppression
- **Cryogenic Accelerometers**
 - Dissipate 40 mW and very often do not work at low T
- **Beware of instrumentation that uses “cryogenic” in the title – it’s usually not!**

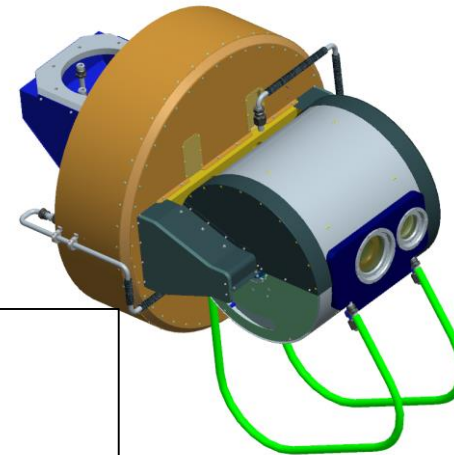




Testing Optical Ground Support Equipment (GSE)



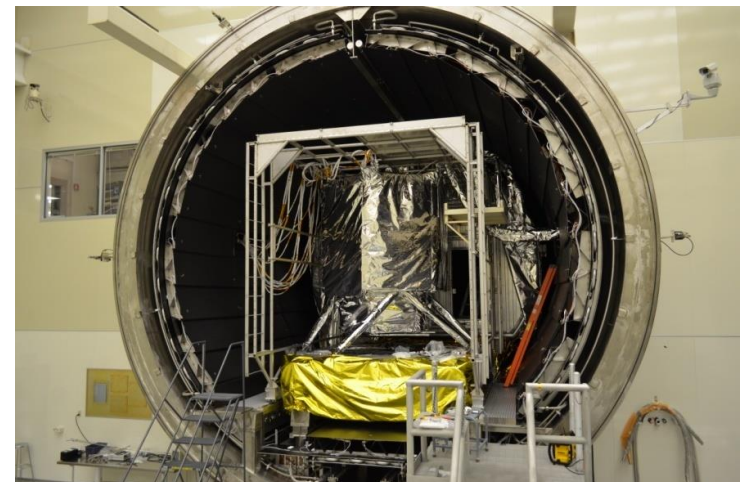
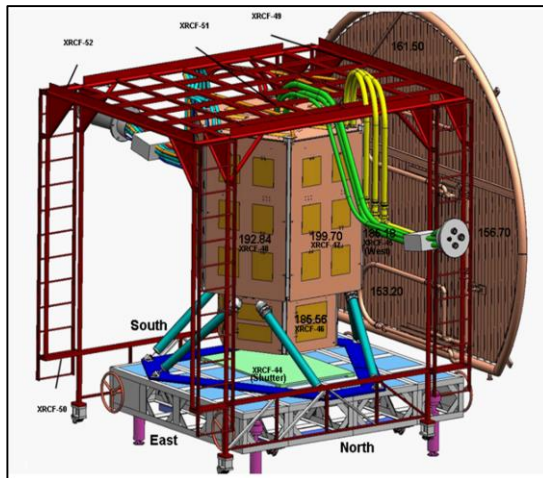
- Cryogenic Photogrammetry Modules (CPMs)
- Center of Curvature Optical Assembly (CoCOA)



Camera
& Source
Windows

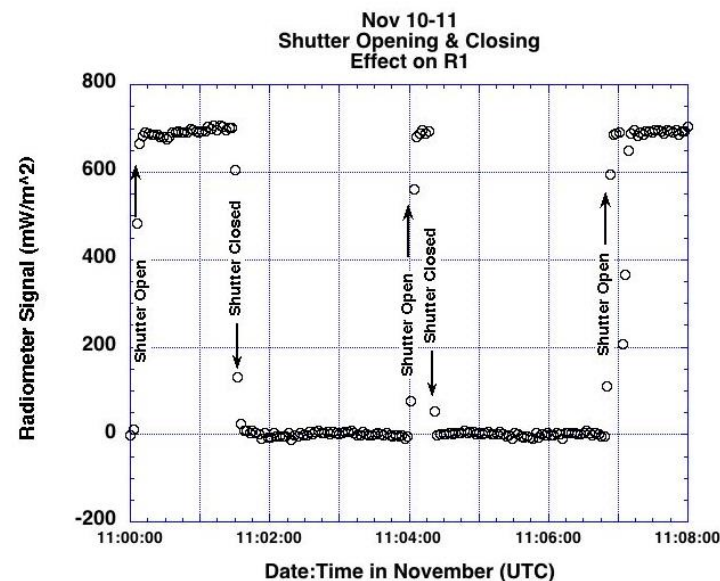
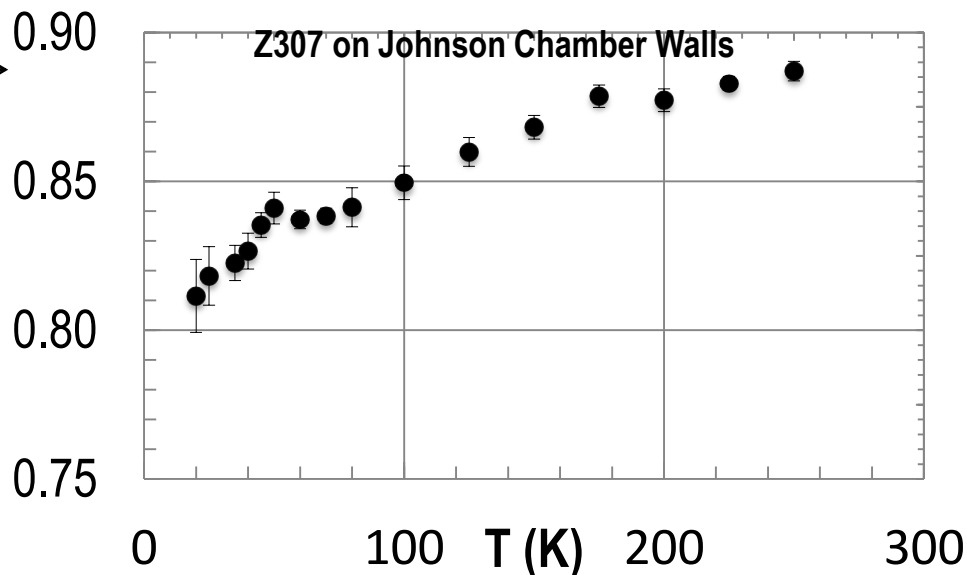
Helium Cooling
Lines

Room T CoCOA
Surrounded by MLI
And Heater Panels
(shutter is at bottom)
(Purge Lines shown in Green)



The Little Tests

- **Shroud emissivity** →
- **Shroud specularity**
 - >98% for mid IR
- **CPM stray radiation**
 - Measured and acceptable
 - Radiation from windows <25 mW
- **CoCOA stray radiation**
 - CoCOA plug shows very little reflection
 - CoCOA Shutter blocks $T > 70$ radiation →





The Big Tests

- Chamber Commissioning
- Optical GSE 1
- Optical GSE 2
- Thermal Pathfinder





Leak Checking



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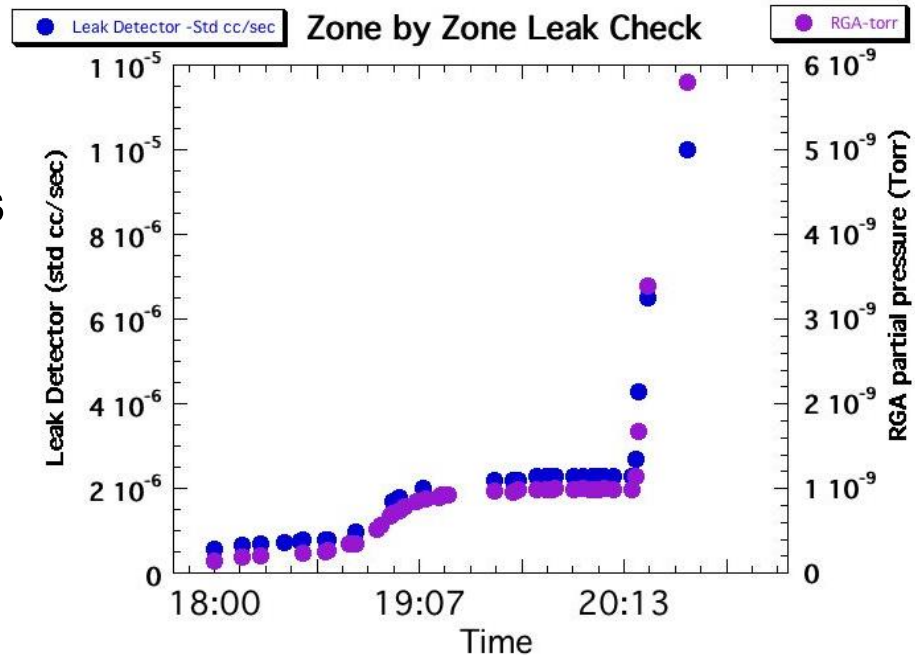
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Helium Leak Checks

Example finding major contributions

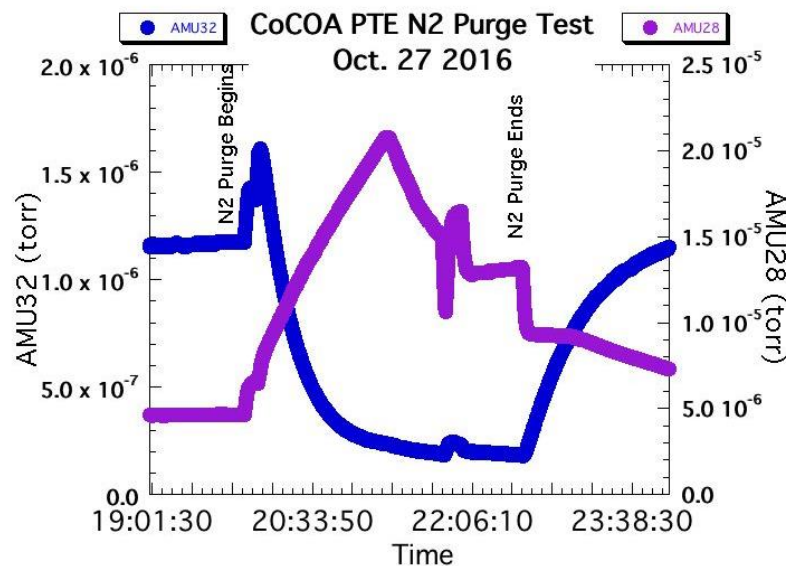
- PG circuit leak is greatest
- Leak detector and RGA are proportional



Air Leak Checks

Example: proving air leak in purge system

- Helium could not be used
- RGA proves to be a good leak detector





Summary



- **JWST is a very complex space mission**
- **Integration and Test provided new challenges**
 - Huge Cold Telescope
 - Warm GSE in the Same Chamber
- **Risk Reduction for the final cryogenic test required several preparatory tests**
- **We are now ready for the real thing!**





JWST Arrives for Final Cryo Test



Questions?

